

Most countries have national programs to increase the public awareness and understanding of science. The assumption behind these programs is that a scientifically literate population will ultimately lead to a healthy and economically prosperous country. How do we know if these programs achieve their aims? Are they evaluated, and if so, what methods are used? This report looks at the way the Australian Science and Technology Awareness Program has been evaluated and comments on the limitations of the methods used. It proposes a simple five-point model for evaluation. The conclusion is that the credibility of programs designed to enhance the public communication of science and technology will be questioned and funding threatened unless science communicators devote more resources to evaluation. On May 30, 2001, the Science and Technology Awareness Program was replaced by the National Innovation Awareness Strategy, a body with similar responsibilities.

Report: The Evaluation of National Programs of Science Awareness

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Many countries around the world support programs to increase the public awareness of science and technology. These programs have specific aims and objectives because governments like to know how and why their money is being spent. While there may be a difference in emphasis between national programs (between understanding, awareness, and communication), the reasoning behind most of them runs like this:

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1. Nations want a modern, knowledge-based economy.
2. Only this sort of economy will deliver satisfying, well-paid, sustainable jobs and ensure national prosperity.
3. Nations believe they can achieve this sort of economy if they have a population that understands and appreciates science.
4. Nations need a population that understands health and safety issues, like AIDS.
5. There is a desire to ensure the next generation of scientists and technologists and to stimulate students to do science at school and university, particularly in the "hard" sciences like mathematics, physics, and chemistry.
6. Therefore, governments fund projects to bring science to people and to show them how relevant, interesting, and important science is.

These projects may include science shows, solar boat races, open days at research organizations, funding new programs on radio and television, giving prizes for outstanding media coverage of science, stimulating new educational materials, and running educational programs to deal with particular issues for special target groups.

Quite often, the national programs have special target groups. The South African program, for instance, targets learners, educators, women, youth, and the disabled. On the other hand, the Irish program targets "decision-makers in the public and private sectors and also in the education and business sectors, the media and the general public." This emphasis on economic outcomes is common, although national programs can include social or environmental aims.

What is known about whether these programs work? Are their objectives ever tested? How do people running programs in the public awareness or understanding of science and technology evaluate their programs?

The groundwork for this report was laid at an informal meeting of the Scientific Committee of the Public Communication of Science and Technology (PCST) group in Budapest, at the World Conference on Science in 1998. The issue of evaluation was discussed in the context of the program of the next international conference of the group, then planned for Geneva in 2001. It was recognized that current evaluation processes were a weakness in many programs and projects designed to increase public communication of science and technology. Furthermore, whenever inadequate evaluation exists, it undermines the credibility of much of what science communicators strive to do in these programs.

Unless the benefits of these programs can be demonstrated, skeptical governments are entitled to doubt the programs' achievements and question their continued funding. The proponents of these programs need to be able to show they have made a difference—that the activities they have designed and put into action have led to the desired outcomes. Evaluation is a key issue.

Considerations Central to an Evaluation Process

Evaluation Should Be Built into a Program from the Start

Objectives of the program should follow the SMART rule—simple, measurable, achievable, realistic, time bound. The difficulty with many of the national programs is that their objectives are anything but SMART. They tend to be CUT—complex, unmeasurable, and lacking timeliness. This is because those who design PCST programs tend to forget about evaluation during the design stage, or they consider evaluation well after the objectives of the program have been set, which is too late in the process.

For example, the objective of Australia's Science and Technology Awareness Program (STAP) is "to develop a greater understanding in the wider Australian community of the important roles played by science, technology and innovation in all aspects of our life, and particularly in economic and social development." This is more like a mission statement than an objective, and it needs to be fleshed out with a series of operational statements setting out what the program is going to do in simple measurable terms. Measurable criteria will enable an assessment of the effectiveness of the program. These measures (or performance indicators) could include the following:

- the number of high school students completing science courses,
- science coverage in popular media,
- movement in the salary levels of scientists and technologists,
- the number of scientists elected to Parliament,
- changes in attitudes toward science measured at focus groups and by surveys,
- the number of people enrolling in combined science-economics degrees,
- the number of high-profile board members holding a science or engineering degree,
- the way scientists are depicted in popular films and television shows, and
- the number of females graduating from universities with a science degree.

So, if school and university science courses were overwhelmed with new enrollments, if salary levels for scientists shot upward, if scientists were treated with dignity and respect on popular television programs, if the circulation figures for science magazines doubled, and if many scientists were elected to Parliament, then their proponents could claim that the programs of national awareness were working!

It is important here to acknowledge that the link between cause and effect can be notoriously hard to demonstrate in these areas. Can it be shown that the program rather than some outside influence caused a certain effect? The activities of national programs like STAP are complemented by the work of science centers, museums, and educational organizations. Thus, other events and other programs with overlapping aims are happening at the same time. As an example, the number of new technology start-up companies may suddenly increase after a business awareness program. What influence has the awareness program had, compared to a change in the tax rate that made this sort of investment much more attractive, or a series of seminars run by the university?

Baseline Data Should Be Used as a Measure of Where the Population Is before the Program Is Run

Then, after the new program is run, any changes in attitudes or behavior can be measured against this previously established baseline. An example of baseline data for a project designed to build awareness of career opportunities for women in science would be to collect statistics on the number of female students enrolled in science courses before the awareness project commences. Then, data would be collected again after the project has been implemented to measure any changes.

There are other matters to be considered in working out the best approach to use to evaluate a program. The process may take a summative approach, which depends on matching the objectives of the program with its outcomes. In this case, the question to ask is, "Did the project meet its objectives?" The evaluation process compares the "before" picture with the "after" picture to assess whether the program changed anything.

Or it may be appropriate to take a formative approach, in which the program can be modified and improved while it is under way. The formative approach overcomes the difficulty of having to wait until the end of the program before carrying out evaluation, as one must under a summative assessment process. This is largely a matter of building in monitoring and tracking mechanisms prior to commencement of the program. Here is a string of assessment tools that could be used in making summative or formative evaluations:

- focus groups
- unstructured interviews

- questionnaires
- surveys
- opinion polls
- observing behavioral change
- analyzing feedback
- desktop analysis of newspaper clippings

This is not a complete list, of course, and this report is not an exhaustive discussion about the intricacies of evaluation. Material on this subject is readily available for persons wanting to pursue the topic. One discussion that relates to science events is Boddington and Coe's "So Did It Work?" which is available on the Web at <http://www.royalsoc.ac.uk/scforall/copusSodiditwork.pdf>. Unfortunately, this study omits any references to establishing baseline data, but it is useful nonetheless.

We have developed a simple model that could be used for the evaluation of programs or projects that aim to change or influence public views on science and technology. This model includes the following five steps:

1. Identify clear objectives for the program or project, for example, to increase the awareness of high school students about career opportunities in science. This project could have as a performance indicator the students' level of awareness about science career options.
2. Identify the audience to be influenced, and then establish baseline data. For the example of high school students, this baseline data could be a measurement of the current awareness of students before implementation of the awareness project.
3. Identify the most appropriate method to assess change by choosing from the range of assessment tools listed earlier. Using the school example, the selected method could be to conduct telephone interviews with a representative sample of students.
4. Carry out ongoing assessment during a project as a way to shape the program. The aim is to improve effectiveness and to save time and money. Again, in the school example, the project team may discover that the photographs of scientists used in the project reinforce negative images, and so the material needs to be revised. This revision can be made while the project progresses.
5. Carry out postproject assessment, again by choosing from the possible tools listed earlier.

A similar model is proposed in a booklet published by the International Public Relations Association, "Public Relations Evaluation: Professional Accountability" (Gold Paper No. 11, November 1994).

Programs to Boost the National Awareness of Science

Many countries in the world have national programs designed to increase public understanding or public awareness of science. A cursory search of the Web provides the following examples.

Ireland has the Science Technology and Innovation Awareness Program with the overall theme of "Science for a Successful Ireland." The program was established in response to the Tierney report of 1996, which called for:

a new vision of innovation in Ireland which will provide the motivation for enterprises, individuals and the public sector. . . . Paramount to this vision is a change in our cultural approach to risk-taking and the need for a long-term view. (Science, Technology and Innovation Advisory Council Report 1995)

As indicated earlier in this report, the Irish government has targeted the program "particularly at decision-makers in the public and private sectors and also at the education and business sectors, the media and the general public."

South Africa has established the National System of Innovation (NSI), which says that "All South Africans should participate. . . . It requires a society that understands and values science, engineering and technology . . . thereby ensuring national prosperity and [a] sustainable environment." In particular, the NSI is seen as a way to empower South Africans as they "seek to achieve social, political, economic, and environmental goals."

In Germany in May 1999, the leading organizations of the sciences, upon the initiative of the Donors Association for the Promotion of Sciences and Humanity in Germany, decided to develop a dialogue with all groups of society. The result is a nationwide initiative called Science in Dialogue. It aims to open a dialogue with all members of society, provide information about methods and processes of research, and highlight the mutual dependency of science, the economy, and society.

New Zealand has a Science and Technology Promotion Program to generate a culture that understands and supports science and technology as integral to the country's future prosperity and well-being. The program wants New Zealanders:

to better appreciate the positive role science and technology can play in the economic, social and environmental well-being of their country, themselves and their communities; and to embrace science and technology as pivotal in a knowledge-based society, and essential to the creation of a desirable future.

In Great Britain, the British Association for the Advancement of Science “works throughout the UK to promote understanding and development of science, engineering and technology, and to illuminate and enhance their contributions to cultural, economic and social life.”

In 1989, Australia established a national program, STAP, to increase the public understanding of science and technology issues. The aim of STAP was “to develop a greater understanding in the wider Australian community of the important roles played by science, technology and innovation in all aspects of our life, and particularly in economic and social development.”

The STAP Web site expands on this statement to explain the thinking behind the program. The language and reasoning is essentially couched in economic terms and will be familiar to readers who have looked at national programs in other countries:

Society depends more and more on science and technology to supply knowledge and information, to find answers to new and pressing problems and to help maintain the high standard of living we now enjoy. A community which is informed about and at ease with the subject is better able to debate and make informed decisions on science and technology issues. Science and technology can give our industries a competitive edge. They help us pursue sustainable development which is ecologically friendly and also improves our economic and social well being. (See <http://www.isr.gov.au/science/stap/>)

What does STAP do, and what sort of budget does it have? A summary of activities is described on its Web site. Among other things, it

- runs the Prime Minister’s annual science prize,
- sponsors awards for science journalists,
- administers small grants for individual science awareness-raising projects,
- participates in and partially funds National Science Week,
- publishes a newsletter and maintains a register of science communicators,
- periodically assesses Australians’ attitudes to and understanding of science and technology, and
- counts media coverage of science.

To run these activities, STAP has a modest budget of about \$U.S.1.5 million per year. This funding is leveraged through partnerships with organizations such as science museums. It aims to reach five target audiences: young people and their teachers; women; industry and business leaders; scientists, technologists, and engineers; and journalists and other media practitioners.

STAP’s objectives are typical of national programs to promote the public understanding of science, and the details of these national programs are

similar as well. They target the same key groups—women, the young, teachers, and business leaders—and they encourage and support the same sorts of activities to reach these target audiences. They also emphasize the benefits of increased economic activity and an improved environment. But none of these programs has an obvious strategy of evaluation. Therefore, it is not known whether a population that understands and is more aware of science and technology will be more supportive. Nor has the larger link been tested in these programs, that is, the link between a more aware population and increased economic performance.

Do PCST National Programs Work?

To provide some insight into the question of whether national PCST programs work, it is useful to take a close look at the Australian STAP. STAP has been involved in a number of reviews by external consultants both to assess its effectiveness and to shape its strategy. The methodology and conclusions of these reviews will serve to illustrate issues in the process of evaluation. Specifically, what methods did the consultants use? What conclusions did they reach?

The 1999 review, which was the most recent, was commissioned to

1. review the effectiveness of STAP,
2. identify the science and technology awareness needs and the extent to which these are being met by the current programs, and
3. recommend any changes in the programs necessary to meet current and future objectives.

In their report, the consultants provided some guidance as to their methodology:

This 1999 review of the STAP program has involved extensive consultations with key stakeholders, review of existing materials, programs and research; assessment of other relevant government programs; development of options for reform of existing STAP programs; and identification of possible new programs. . . . As part of this review of STAP, Buchan [the consultants] consulted with a wide range of stakeholders and received a number of written submissions.

These consultations involved meetings with individuals and groups across Australia, including the chief scientist, the national science minister's office, organizers of events such as National Science Week and the Science Olympiads, the Australian Broadcasting Corporation (responsible for almost all

television and radio science shows in the country), officials from relevant government agencies, museum personnel, and groups from business and industry. In addition, the consultants met major grant recipients and reviewed program reports.

There were also twenty-three written submissions from bodies including the Australian Academy of Science, the Federation of Australian Scientific and Technological Societies, the Science Teachers' Association, the Australian Science Festival, and the Australian Museum. Buchan reviewed reports on existing projects and questioned major grant recipients. Further components consisted of a limited survey of other science awareness activities in other programs carried out by Australian governments at the federal and regional level and similar activities in the European Economic Union and eight other countries.

The consultants were generally positive, and their report read (in part): "The STAP program has produced some outstanding successes. Our consultations have revealed consistently positive feedback on major elements of the STAP program, and our analysis shows that these programs have produced significant awareness outcomes" (p. IX).

The consultants suggested a new approach, saying that times had changed over the eleven-year life of the program and that STAP needed to focus more on coordination, collaboration, and communication. They said there should be less emphasis on micromanagement and more on developing strategic partnerships to boost funding and program effectiveness. They identified major priorities, recommended a new structure for programs, and suggested an expansion of funding.

They said that STAP provided the government with an opportunity for national leadership and "a potential platform to drive the government's policy agenda in the pursuit of a more innovative economy" (p. XII). The report noted that there are "important issues regarding science awareness that go beyond the terms of reference for this Review" and suggested these matters be explored by the Prime Minister's Science, Engineering and Innovation Council. This was tacit recognition that the review would not be able to deal with all the issues connected with a review of STAP.

STAP had earlier been reviewed by another consultant, Woolcott Research, in 1991, 1994, 1997, and 1998. The four reviews Woolcott carried out had similar objectives and similar methodologies. The objective of the 1994 review was typical: "To undertake an assessment of contemporary Australian attitudes to science and technology, to analyse these in the context of past research and the goals of the Awareness Program, and to make recommendations for its future strategy."

Woolcott's methodology had both qualitative and quantitative elements, and it gathered information through group discussions, telephone interviews, individual in-depth interviews, and random surveys of citizens older than the age of fourteen. The reviews have enabled the government to track changes in Australian attitudes on questions such as

- the perceived importance of science and technology in everyday life,
- the importance of science and technology in Australia's economic future,
- the reward of careers for young people studying science and technology, and
- the suitability of careers and study for women in science and technology.

Just how useful are these reviews by Buchan and Woolcott?

Buchan gives a good picture of how the science community views STAP. Almost without exception, everyone involved in responding to the review was a scientist, worked for a science organization, or worked in science communication. The review examined in some detail questions such as,

- Did the science community approve of the STAP projects?
- Was STAP an efficient delivery vehicle for converting government funding into science communication projects?
- Was the level of funding adequate?
- What was the target audience, and how many people were reached?

Not surprisingly, the science community liked the projects but wanted a change in the balance of funding, had various opinions on the efficiency of STAP as a funding mechanism, and thought that STAP should be given more money to fund additional programs the science community wanted. The Buchan review did not assess whether Australian attitudes toward science and technology were changing or whether the activities promoted by STAP were responsible for any changes in attitude if such changes occurred. It should be noted that budgetary constraints did not allow the Buchan consultants to commission new research.

The Woolcott reviews do measure changes in Australian attitudes to science and technology but not whether STAP caused these changes.

There is value in both the Buchan and Woolcott reviews, and both contribute to an overall picture of science awareness and attitudes in Australia. However, neither established a link between the activities supported and funded by STAP and changes in Australian attitudes to and understanding of science. Therefore, it is still not known if STAP has caused Australians to become more or less aware of science and technology or of the part science plays in stimulating economic and social development.

Conclusion

Many governments fund PCST activities because they hope such activities will have an economic pay-off and because they hope a community interested in and informed about science will support science. But they do so as an act of faith. Governments and the people responsible for PCST programs really do not know if PCST activities change community attitudes or if an informed community will support science.

The workshop following the presentation of this paper at the PCST conference in Geneva in February 2001 considered presentations on PCST programs in South Africa, Poland, Thailand, and an international health program. The description of these programs and the ensuing discussion demonstrated that evaluation was not a fundamental design element of the programs, and the organizers relied on superficial measures such as attendance at events to justify the programs. (See *Science Communication*, Vol. 22, No. 4, 438-41, for a report of that conference.)

The key point is that science communicators need to introduce more science into their work. Evaluation is not a trivial task, and it can be both complex and expensive. It needs to be considered from the time a project is conceived and carried out in a methodical and thoughtful manner. The value of evaluation often will not be apparent until after the project is completed; but where there is a weakness, it undermines the credibility of programs designed to enhance PCST and poses a long-term threat to their continuation.

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